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ABSTRACT

The use of computer assisted therapy (CAT) in the rehabilitation of individuals with brain damage is examined. Hardware considerations are explored, and the variety of software programs available for brain injury rehabilitation is discussed. Structured testing and treatment programs in time measurement, memory, and direction finding are described, as well as such unstructured programs as games, puzzles, and educational routines. The use of video games to heighten interest and motivation is noted. Two case studies are offered which compare conventional therapy and CAT for head injury victims. The paper concludes with a brief discussion of problems in rehabilitation of persons with head injuries, including resistance of insurance companies to pay for computer equipment. (CL)

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The Use of Computers and Video Games In Brain Damage Therapy

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Running Head: Computer Assisted Therapy

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The Use of Computers and Video Games in
Brain Damage Therapy

Modern technology has presented medical science with a powerful tool for cognitive rehabilitation--the electronic computer. The computer can be used to identify the nature of various brain deficits, treat those deficits and supply records of the patient's progress.

The computer should be used as an adjunct to, not a replacement for, a thorough treatment program. "It focuses on 'cognitive' as opposed to 'physical' therapy in the treatment of survivors of strokes, head injuries and other causes of brain injury" (Gianutsos & Klitzner, Note 1, p.3).

The causes of brain damage can be generally categorized as internal or external. The internal causes include cerebral hemorrhage, stroke, cysts or other growths on the brain. External brain damage is caused by a blow to the head such as those caused by gunshot wounds, falls, automobile accidents, etc. Automobile accidents account for the highest number of head injuries (See Tables 1 and 2.).

Insert Tables 1 and 2 about here

About 1.5 million head injuries occur annually in the United States (Lynch, Note 2). "Even more staggering is the fact that 50,000 people a year who survive a serious head injury, are left with intellectual impairment

of such a degree as to preclude their return to a normal life" (NHIF, Note 3). Brain damage has become such a common facet of our society that it is aptly called "The Silent Epidemic" by the National Head Injury Foundation. Life can never be the same for the victims of brain damage, their families and close friends.

An injury to the brain is not some relatively minor thing that needs only proper medical care and the time necessary for physical healing to take place. The brain-damaged victim often suffers problems of cognition. "The word cognition means knowing or understanding and brain injury frequently affects the way people know or understand their environment" (Gianutsos, 1980, p.37). Cognition treats the acquisition and use of knowledge. Often the most basic skills such as walking, talking, writing, calculating, perception, etc. must be relearned.

Memory impairment to some degree almost always accompanies brain injury. But since memory dysfuncion is often accompanied by perceptual and/or language difficulties, the techniques for memory retraining have developed into a highly extensive series of <u>interrelated</u> treatments that must all be incorporated into a comprehensive rehabilitation program.

There are two methods of rehabilitation discussed in this paper. The conventional method refers to rehabilitation done on a one-to-one basis between therapist and

client. A second method is Computer Assisted Therapy (CAT) in which conventional methods are aided by the highly diverse and flexible tool, the computer.

Conventional therapy is labor intensive and time consuming (Lakin, Note 4). A large amount of time is used getting the therapist and patient together and then delivering the treatment on a one-to-one basis, not to mention the time taken to train qualified therapists.

Among those neurological deficits treated in cognitive rehabilitation are visual tracking, information processing and pattern recognition. Visual tracking includes being able to follow lines of print or control eye movements. Realizing when to get gas when the gauge reads "low" is a type of information processing. Recognizing weather signs to forecast the weather is a pattern recognition ability.

Technology has presented us with some excellent tools which can be used to tremendous advantage, providing therapy for the victims of brain injury. Among those tools are the computer, video games and various combinations of the two.

There are many diagnostic procedures and subsequent therapeutic exercises which can be conducted with the use of a computer system. The brain-injured individual and the computer system interact, allowing the patient control

over the outcome of his treatment. At this point it can be extremely valuable for the patient to recognize his or her own control of the rate and eventual results of the treatment. No longer must the patient feel controlled by outside forces which may be only dimly understood.

There are many hardware characteristics to be considered when choosing a computer system for use in CAT. Among the specifics to be considered are speed, serviceability, memory, display, color, graphics, versatility and dependability.

It is important to know whether or not to get a single self-contained computer unit or a modular system. A self-contained unit is one piece; a modular unit is in modes or sections, such as the keyboard, the central processing unit, the disc drive, the monitor, and the printer. A modular system will allow for substitutions, such as specialized keyboards, wider displays, audio instead of printed output, etc. With a modular system, mode repair and replacement allow continued use during repair and service (Gianutsos, Note 5).

There are different types of computer programs used for brain injury rehabilitation. The specific program used will depend on the needs of the individual as determined by specialists, e.g. doctors, clinicians, therapists.

The programs used for cognitive rehabilitation can be generally classified as structured or unstructured.

The structured programs are typically used in formal therapeutic sessions. Among these are programs used for testing the client in areas of neuropsychology, complex attention and digit function. Some examples of computer programs used in the initial, formal therapeutic sessions are programs that treat perception and memory.

One program that tests and treats perception is Speeded Reading of Word Lists, SPWL. This program is used to help diagnose and treat the functions of visual information processing. After the program is used in diagnosis to help identify the problems, it can also be used for rehabilitation.

Another program, REACT, is used to measure the response time to visual stimuli which appear at varying places on the viewing screen. The computer keeps track of these times and displays the results (Gianutsos & Klitzner, Note 1).

A common deficit among brain injury victims is an inability to organize information. A program which is generalized to the activities of daily life is called SHOPPING LISTS. A common complaint among patients was to go to the grocery store to shop, but upon arrival,

being unable to remember what they were supposed to buy. SHOPPING LISTS presents grocery lists that require mental organization and reinforcement. Scoring is done on a percentage basis with some points awarded for correct answers (Parente & Anderson, 1984).

Some brain injury victims are left without any awareness of time measurement and its value in our lives. A program used to reintroduce those patients to a sense of time flow is called TIME-SENSE. The patient is presented with a graphic representation of a clock on the video screen. When the program begins, the clock ticks off a randomly determined period of time, such as five minutes. The patient is required to emulate the clock and guess at the amount of time that has passed. Repeated use of this type of program will replace the awareness of time flow which is central to our existence as human beings (Van Doren, 1984).

CITY MAP treats problems with memory and direction finding. A fictitious map is displayed on the video screen. A small flashing light (a "cursor") represents the patient and indicates the patient's position. The final destination (patient's goal) is also indicated. The patient is supposed to move his "cursor" via keyboard control to his final destination. In the process he must

obey traffic lights, speed limits, one-way street signs, etc. (Cognitive Rehabilitation, 1984).

There are also administrative programs such as LOG which keep records of patient activity. These programs work in conjunction with a printer to provide permanent records of client progress and any other administrative records which may also be required. In addition, there are complete programs for clinical and medical use and other data base management systems (Gianutsos & Klitzner, Note 1).

There is a difference between the data base management systems and spreadsheet files. Basically data base management systems are for record keeping. The spreadsheet files can be used for the kind of data manipulation that allows future predictions, advance program planning and any therapeutic changes that may be needed on an individual basis. Both types of operating systems are useful in the administration of therapeutic programs.

Unstructured programs include games, educational routines, spelling, vocabulary or other puzzles. These train concentration and perception (Lynch, Note 6). The games range in difficulty from very simple concepts to more complex and interrelated challenges. PONG, for example, only requires that the patient intercept a ball of light. But SUPER BREAKOUT requires that the player man-

ipulate a ball of light with a control "paddle." This game is more difficult because the angle and speed of the ball changes as the game is played (Lynch, 1983).

COMPU-READ is a reading assessment and training program. This program consists of four parts--Letter Recognition, Rapid Word Recognition, Synonyms and Sentence Comprehension. It adjusts exposure times of the stimuli in direct response to the patient's response via keyboard. As the patient experiences continued success, exposure time becomes briefer (Lynch, Note 7).

TIC-TAC-TOE, TARGET PRACTICE, CHECKERS and MAZE SOLUTION are all examples of unstructured software that challenge perception. CONCENTRATION, MASTERMIND and TOWERS OF HANOI are programs that exercise memory. Educational programs are available for I.Q. building or reconstruction, and number drills. There are also mathematics and reading series which can be tailored to fit any level of treatment (Gianutsos, Note 4; Lynch, Note 8).

In 1978 standard home video games were provided for use at the Brain Injury Rehabilitation Unit in the Palo Alto, California Veterans' Administration Medical Center. At that time there was no plan to use video games in cognitive rehabilitation; they were meant only for patient recreation. It soon became apparent, however, that the abilities required to play the games, such as speeded

reaction time, eye-hand coordination, concentration, memory, visual tracking and mathematical skills, were the same ability deficits being treated at the hospital. As a result, the games were incorporated into the standard program of treatments designed to remediate deficits in the areas of thinking, reasoning, memory and fine eye-hand coordination (Lynch, 1983). Furthermore, the patients obviously enjoyed working with computers and video games, thus turning tedious rehabilitation into a pleasant process.

Rehabilitation involves a seemingly endless round of frustration, challenge, drills and constant repetition. A perfect way to avoid this patient frustration and rejection of therapy is to make it fun. If video games naturally lessen an otherwise trying activity and yet, continue constructive treatment, they are highly recommended. A device which improves the patient's state of mind while delivering constructive therapy can only be considered a very good tool.

Although computers and video games have proven to be valuable in the rehabilitation process, there are limitations. Arcade video games employ a sensory barrage of loud, sudden noises, multicolored flashing lights, themes of attack, threat, defense and inflicted harm. That kind of assault on the senses of someone who is used to the

ordered quiet of a hospital setting can be extremely unsettling and harmful (Lynch, Note 9).

Video games and computers must never become a replacement for human intervention and contact. Only another person can express the care and human feeling of working with a patient toward the common goal of rehabilitation. That contact is impossible for any machine to express, no matter how sophisticated the machine may be.

No computer program is naturally suited to every particular type of injury, personality or circumstance. In each individual case, the physiology of the patient, related medical and social circumstances and immediate family situation are among the many variables that must be considered. Although there are certain similarities among all brain injury victims, the effects of each injury are as personalized as fingerprints. That is why all phases of treatment must be under the direction of qualified personnel.

Two Case Studies Comparing Conventional Therapy and CAT

The following case studies summarize treatment given to two head injury victims. The victims are similar regarding sex and general age. However, there are many independent variables in both cases whereby the interaction of these variables could easily bring about many different and unexpected results. For example, testing revealed that Mr. T had average intelligence after his accident; Mr. L's I.Q. following his accident was not disclosed in his case study. One neurological deficit that is common in both cases is memory dysfunction.

The first case, Mr. T, was a 23-year-old college student. Mr. T was involved in a car accident that resulted in a cerebral contusion with left-frontal edema and right hemiparesis. Aside from memory loss, Mr. T also suffered verbal expressive difficulties and was referred to a speech therapist for specific treatment in this area.

Mr. T was seen after his accident by Russel E. Glasgow and Manuel Barrera, Jr. who, with two other authors, subsequently published the case study in the Journal of Clinical Psychology in 1977 (Glasgow, Zeiss, Barrera, & Lewinsohn, 1977). Mr. T was treated for 19 weeks for his difficulty in remembering the names of people whom he

frequently encountered.

Visual imagery and mnemonic procedures were used to form mental linkage images to treat memory deficit. Subsequent in vivo applications of personalized therapy procedures were applied. The authors noted that this case required a great deal of therapist time. They hoped that standardized assessment and treatment modules would be developed for specific problems of brain-damaged individuals. Such programs could then be implemented by paraprofessionals and save a great deal of the therapist's time (Glasgow, et al,, 1977).

Mr. T was treated by conventional methods. It is possible that had Mr. T been able to utilize CAT, therapy time might have been reduced.

An example of commercially available programs that can help in this particular area is the program called EINSTEIN MEMORY TRAINER. This program is designed to enhance memory skills in non-brain-injured individuals but is well-suited for brain-injured victims. Dr. William J. Lynch (Note 10, pp.6-7) states, "The patient is given pre-tests, training and post-tests in the general areas of remembering names and faces, phone numbers and addresses. The methods of loci and pegnames are among the techniques taught. The program is attractively illustrated, completely menu-driven and resistant to input errors, making

it accessible to patients who may not have close, constant supervision."

The second case, Mr. L, suffered a severe closed-head injury in a motorcycle accident. He was an air force veteran, 23 years old, and in a coma for three months following his accident.

A year and a half after his injury he plateaued on conventional therapy. Mr. L was evaluated as also having a series of physical problems, including manual dexterity. One hand was totally non-functional and the other was spastic and ataxic. It was adequate for keyboard use but barely capable of writing. This meant that note-taking as a memory aid was an unrealistic goal for Mr. L. Furthermore, word fluency was low and spelling was poor (Gianutsos, Note 5).

He was placed on a weekly therapeutic program. A computer was used at every session. The programs MEMORY SPAN and TRIPLET RECALL were subsequently used to train short-term and long-term memory storage. Dramatic improvements were noted by his family and the staff at his training facility. (Note: The therapeutic program was augmented by CAT practice at home since the patient and his family purchased their own computer.)

The therapy sessions also used game and puzzle programs such as CONCENTRATION and THE TOWERS OF HANOI.

The patient showed enthusiasm for the programs and made almost daily use of the computer over a six month period. He used it by himself and made entries, using the LOG program. The administrative LOG shows a marked increase in initiative and verbal fluency (See Figure 1.). This increase was also noted by his family (Gianutsos, Note 5).

(Insert Figure 1 about here.)

Using computers for administration of carefully planned exercises, patient evaluation and administrative and/or record keeping functions is valuable to both patient and therapist. However, we must never totally lose the basic necessity of human contact. Only by constant or periodic direct association with a therapist can the patient achieve the maximum benefit of a therapeutic program.

With standardization of assessment and treatment programs, the time used for these necessary activities is reduced. Also, the patient's attitude toward the otherwise depressing necessity of rehabilitation is improved by constructive game-playing and may become a deciding factor in the patient's rehabilitation.

Discussion

Computer Assisted Therapy is a new field and is enthusiastically embraced by many of the professionals involved. Because computers and programs are commercially available and at a relatively low cost, one would think that CAT would be welcomed by all parties concerned with rehabilitation. Unfortunately, this is not so.

First, we must address the "fantasy factor." There are injuries which do not always show up on conventional forms of x-ray testing. As a result, two schools of thought exist. One school of thought says that the patient is "imagining" the injury; that this is a problem of post-stress syndrome as opposed to real damage. The opposing school of thought disagrees and says that damage may not show up with conventional testing. But whether or not the damage is physical or psychological, <u>it is real nonetheless</u>. As a result, some patients are denied treatment by either conventional or CAT methods.

A second problem lies with third-party payers, i.e. insurance companies. A number of experts in the field note that insurance companies are often reluctant to pay for the hardware, software and the therapist needed to work with the patient. Many insurance companies seem willing to buy the patient a computer and make a monetary allowance for software, but pay for no more than that.

Yet, as I stated earlier, CAT must be supervised by a trained professional.

A third problem deals with the rise of head injuries in the United States. Everyone with whom I spoke and everything I read about this subject made it clear that the greatest single cause of brain injury throughout the country is the automobile accident. This paper is based on statistics that are ten years old! There is a great need for an up-to-date survey that focuses on causes and results of brain injury. We also need a thorough study of the pros and cons of CAT.

Clearly, as the "Silent Epidemic" continues, we will be faced with many thousands of people who need faster, more efficient forms of therapy. The computer is obviously going to be an important tool in this field and we need to learn more about it as quickly as we can. To quote Dr. Lynch (Note 10, p.16), the field of CAT must learn the answers to these important questions: "Is CAT effective? If so, with whom? By whom? When? How often? In what combination? What hardware/software is best?"

In the process of answering these questions, I believe the computer will be seen as one of the most valuable tools available for use in brain damage rehabilitation.

TABLE 1

*Annual occurrence of head and spinal cord injury, by external cause of injury: 1970 through 1974**

Year	External Cause	Estimated New Cases†					
		Head		Spinal Cord		Head &/or Spinal Cord	
		No. (M)	RSE	No. (M)	RSE	No. (M)	RSE
1970	motor vehicle	179	10.1	1	80.7	180	10.0
	falls	75	12.4	0+	—	75	12.4
	all other	79	17.6	3	38.3	82	16.7
1971	motor vehicle	203	12.4	2	53.8	205	12.5
	falls	97	13.3	2	18.7	99	13.0
	all other	78	15.1	2	47.0	79	14.9
1972	motor vehicle	200	6.0	6	39.8	206	6.3
	falls	113	19.2	3	40.9	116	18.7
	all other	70	20.0	16	89.4	86	32.2
1973	motor vehicle	245	27.2	6	30.3	250	26.8
	falls	110	7.1	2	35.3	112	7.0
	all other	145	25.2	1	9.7	146	25.0
1974	motor vehicle	210	9.9	3	20.8	212	9.8
	falls	122	15.7	3	45.8	125	14.4
	all other	97	6.2	4	26.3	99	6.0
total		2021	7.2	54	24.3	2070	7.6

*Estimates pertain to cases of head and spinal cord injury (HSCI) that were first treated as inpatients in the nation's hospitals during the specified year. Persons who sustained HSCI and died at the scene of the injury or were dead on arrival at the hospital were not included in the estimates. Entries in this table may differ from corresponding entries in other tables, due to the adjustment that was used to account for missing information.

†Numbers are in thousands (M). RSE = relative standard error of the estimates.

Source: Kalsbeek, W.D., et al., 1980, Table 11, p.S26.

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TABLE 2

*Frequency of HSCI with associated rate for various categories: 1974**

Category	Estimated Existing Cases†						Rate Per 100,000 Population		
	Head		Spinal Cord		Head &/or Spinal Cord		Head	Spinal Cord	Head &/or Spinal Cord
	No. (M)	RSE	No. (M)	RSE	No. (M)	RSE			
age (yrs)									
under 15	284	9.4	1	70.4	285	9.4	524	3	526
15–24	276	12.7	8	38.0	280	12.6	701	20	712
25–44	165	11.7	15	24.7	179	11.6	315	29	342
45–64	134	16.2	3	33.9	137	15.9	312	6	318
65 & over	67	13.2	1	51.4	68	13.1	307	4	311
race									
white	840	9.0	21	22.5	856	9.1	457	11	465
nonwhite	86	12.8	8	24.1	93	12.5	320	28	349
sex									
male	600	10.7	13	28.9	610	9.4	583	12	594
female	326	7.0	16	21.4	339	7.0	302	15	314
region									
Northeast	208	13.8	2	42.0	208	13.8	419	5	420
South	350	13.4	16	21.7	363	13.2	520	24	539
North Central	206	5.5	6	23.3	212	5.3	357	11	368
West	162	25.9	4	78.7	166	26.7	449	11	460
external									
motor vehicle	491	12.0	15	23.3	501	11.9	233	7	238
falls	220	6.5	4	27.7	224	6.4	104	2	106
all other	215	9.2	10	36.9	224	9.1	102	5	106
total	926	9.0	28	18.1	949	9.0	439	13	450

*Frequency refers to the number of cases of head and spinal cord injury (HSCI) that were first treated as inpatients in the nation's hospitals during the years 1970 through 1974 and that still existed during 1974. Persons who sustained HSCI and died at the scene of the injury or were dead on arrival at the hospital were not included in the estimates

†Numbers are in thousands (M). RSE = relative standard error of the estimates

Source: Kalsbeek, W.D., et al., 1980, Table 12, p. S27.

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Excerpt from LOG made 1 month after starting home computer program

```
Ø/3Ø/81 11:Ø4:4Ø
ON YESTERDAY I RAN TOWERS IN 144 MOVES
-------------------------------------------------------------------
Ø1/3Ø/81 11:Ø9:19
I RUN HANGMAN TODAY
---> PROGRAM: TICTAC
-------------------------------------------------------------------
Ø2/Ø2/81 15:11:24
---> PROGRAM: CONCENTERATION
---> PROGRAM: CONCEN
-------------------------------------------------------------------
Ø2/Ø2/81 15:56:58
IN CONCEN THREE TIMES AT BAT OUT OF 1Ø PAIR I MADE IT IN 22. 2Ø
AND WITHOUT A MISTAKE I MADE IT IN 16
---> PROGRAM:
-------------------------------------------------------------------
Ø2/Ø2/81 16:13:25
---> PROGRAM: MONOPOLY
-------------------------------------------------------------------
Ø2/Ø3/81 Ø5:Ø9:Ø3
---> PROGRAM: MULTDIV
-------------------------------------------------------------------
```

Excerpt from LOG made 3½ months after starting home computer program

```
-------------------------------------------------------------------
Ø4/Ø9/81 Ø9:29:15
---> PROGRAM: CONCEN
---> PROGRAM: CONCEN
-------------------------------------------------------------------
Ø4/Ø9/81 Ø9:43:ØØ
I BEAT THE BRAIN DAMAGED COMPUTER TEN TO ZERO. ON THE OTHER HAND
SHE SAID IF YOUR GOING TO GET COCKY AND BE A SMART ASS I AM GOING
TO TEACH THIS GUY A LESION
SHE BEAT ME SEVEN TO THREE
---> PROGRAM: TOWERS
-------------------------------------------------------------------
Ø4/Ø9/81 1Ø:13:17
I DID TOWERS IN 139 MOVES
---> PROGRAM: HANGMAN
-------------------------------------------------------------------
Ø4/1Ø/81 Ø8:48:Ø2
---> PROGRAM: TOWERS
-------------------------------------------------------------------
Ø4/1Ø81  Ø8;55:3Ø
DID TOWERS OF HANOI IN 132 MOVES.  I AM GETTING BETTER AT THIS //TO
-------------------------------------------------------------------
```

Figure 1: The LOG of a head trauma patient using a microcomputer for therapeutic exercise at home.

Source: Gianutsos, R., Using Microcomputers for Cognitive Rehabilitation, 1981, p.7.

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Figure Caption

Figure 1. The LOG of a head trauma patient using a microcomputer for therapeutic exercise at home.

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